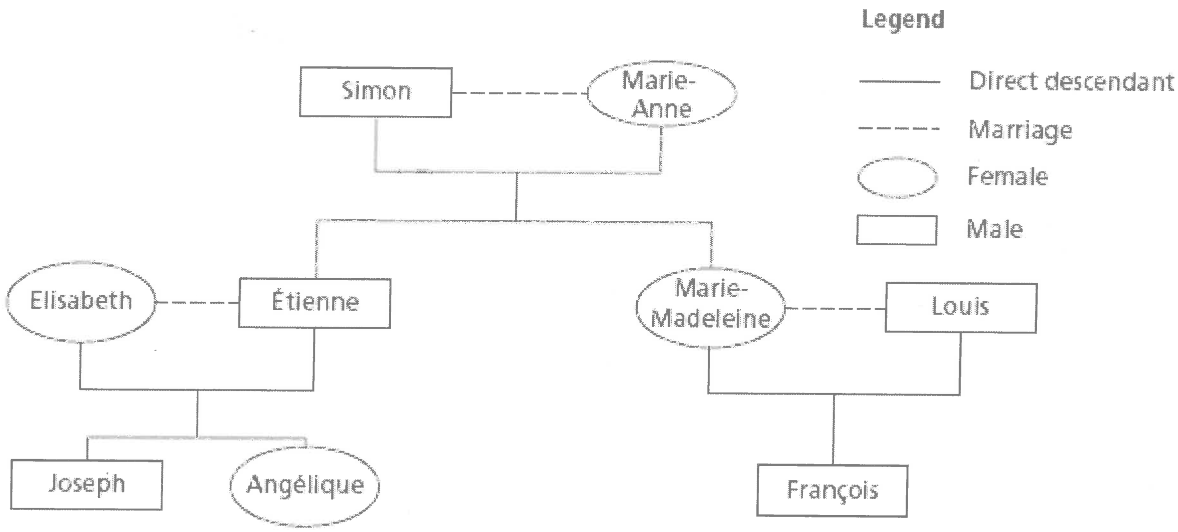
5.1 Representing Relations p. 256

This family tree shows relations within a family.



How is Joseph related to Simon? grandson

How are Angélique and François related? cousin

How does the family tree show these relations? -lines → different kinds
-some names under others
- different shapes

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- a **set** is: a collection of distinct objects (in our case, numbers)

- An **element** ~~is~~: of a set: is one distinct object (number) in the set.

One way to write a set is to list its elements in brackets.

*For example we can write the set of real numbers from 1 to 5 as: **R** = {1,2,3,4,5}

*Any of the numbers in the braces is an element of that set.

(1,2,3,4,5 are each **elements** of the **set** **R** of real numbers from 1 to 5.)

The <u>order</u> of the elements in the set does not matter.

A relation associates the elements of one set with the elements of another set.

- A relation is a rule that **associates** the elements of one set with the elements of another set (like a set of ordered pairs).
- A relation produces **one or more output** numbers for every valid input number.

When we represent **relations** using numbers, a relation is a set of $\boxed{\text{ordered pairs}}$. The elements in the relation are the numbers that represent specific coordinate points on a Cartesian plane.

ie.
{(2,4), (4,8), (6,12)} is a relation
{(boy, 11)} is a relation
{(8:37, bell)} is a relation
{(beef, $17)} is a relation

In this example of a relation (*a set of ordered pairs*): {(1, a), (2, b), (3, c) }, the set of first elements is called the **domain** { 1, 2, 3 }and the set of second elements is called the **range** {a, b, c}.

Ways to represent relations:

Relations can be represented in a number of ways:
1. Table of Values
2. Graphs
3. Arrow Diagrams (mapping diagram)
4. Equations
5. In Words (description)

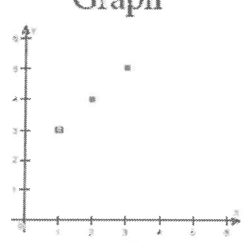
Example 1 – Represent the following relation in 4 different ways:

{(1,3), (2,4), (3,5)} **Recall: (x, y)**

Table of Values

x	y
1	3
2	4
3	5

Graph



Equation

$y = x + 2$

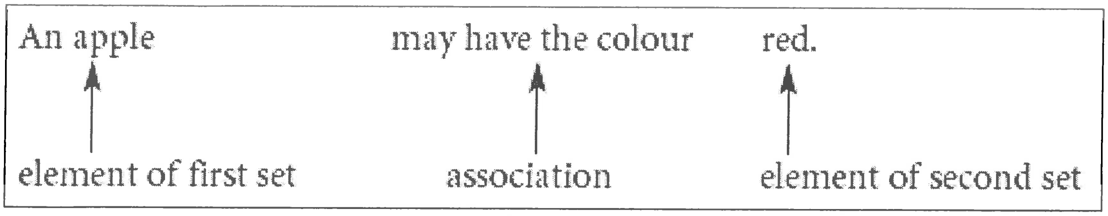
Words

y is always equal to the value of x plus two.

Example 2 – represent a relation in words, in table, in arrow diagram

➔**Consider the set of fruits and the set of colors.**

- We can associate <u>fruits</u> with their <u>colors</u> in words.



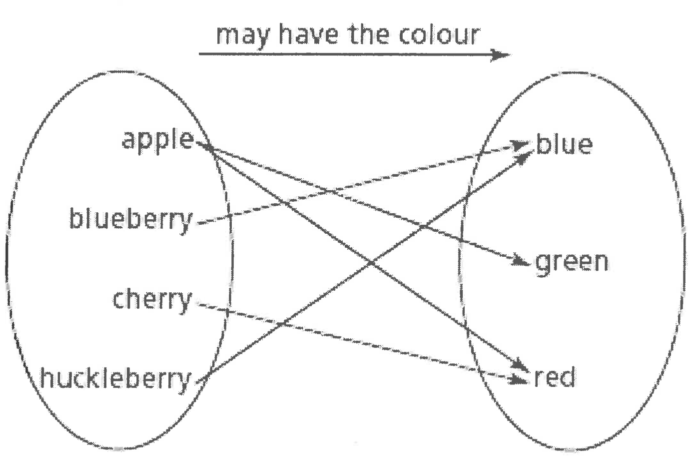
- So the set of **ordered pairs** is a relation.

{(apple, red), (apple, green), (blueberry, blue), (cherry, red), (huckleberry, blue)}

- We can represent the relation in a **table**. The <u>heading of each column</u> describes each <u>set</u>.

Fruit	Colour
apple	red
apple	green
blueberry	blue
cherry	red
huckleberry	blue

- We can represent the relation in an **arrow diagram** *(mapping diagram).* Two **ovals** describe each **set.**
  Each **arrow** <u>associates</u> an element in the 1st set to the 2nd set.

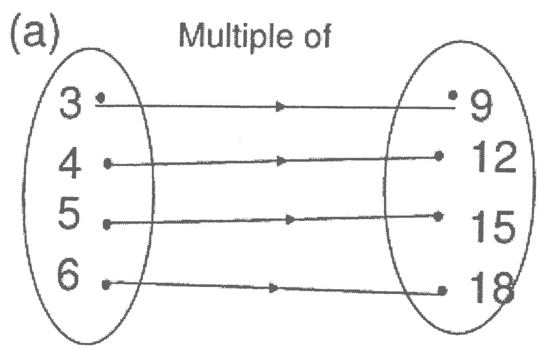


The <u>order</u> of the words in the ordered pairs and <u>which column</u> and <u>which oval</u> the words are in in the table and arrow diagram are important , as is the <u>direction</u> of the <u>arrows</u>.

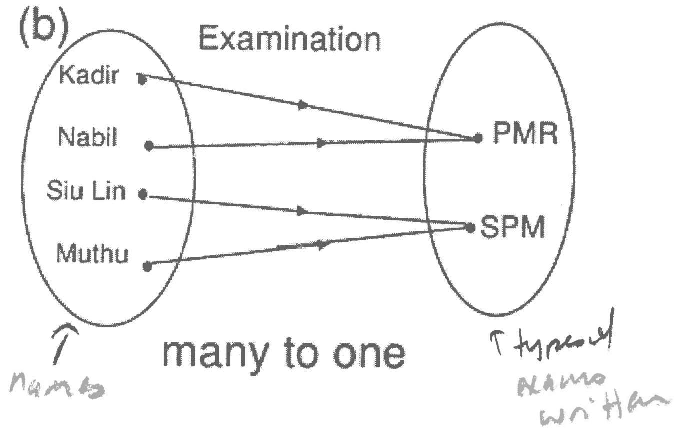
It makes sense to say "an apple may be the color red" but does not make sense to say "red may be the color apple".

That is, **a relation has <u>direction</u> from one set to the other set.**

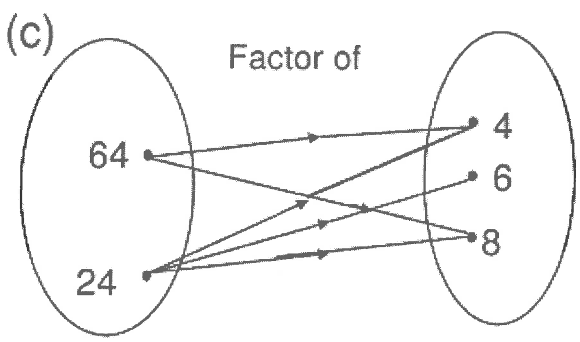
The four main types of relations are shown in the following arrow diagrams.



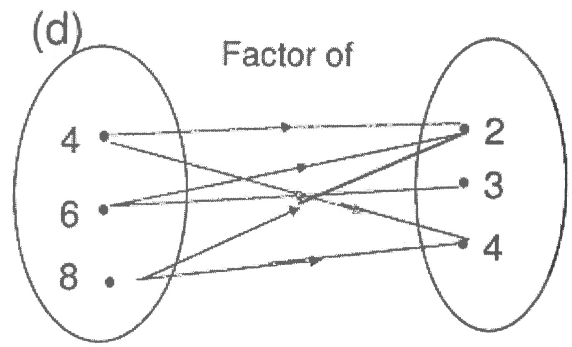
One to one



many to one



One to many



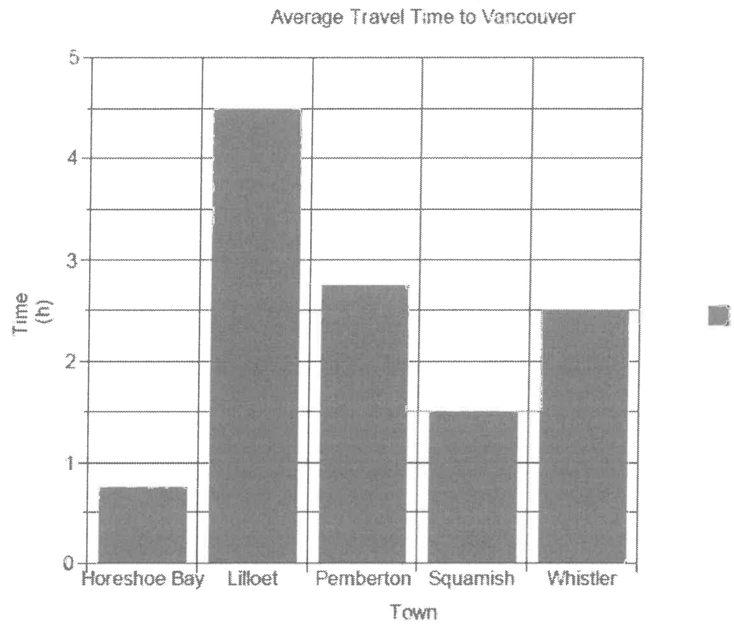
Many to many

Sometimes a relation contains so many ordered pairs that it is impossible to list all of them or to represent them in a table or an arrow diagram.

Representing Relations in words, as a graph, as a table, as an arrow diagram.

Ex. Different towns in British Columbia can be associated with the average time, in hour takes to drive to Vancouver. Consider the relation represented by the following graph.

← words

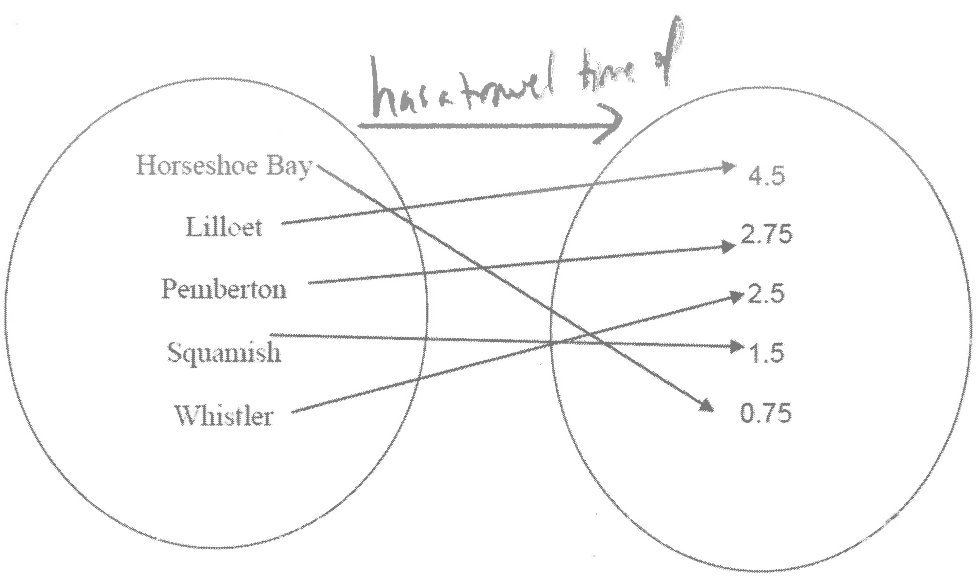


This graph shows the relation "travel time to Vancouver" between a set of towns and a set of travel times.

a) As a table

Town	Average Time(h)
Horseshoe Bay	0.75
Lilloet	4.5
Pemberton	2.75
Squamish	1.5
Whistler	2.5

b) as an arrow diagram:



c) As a set of ordered pairs:

{(Horseshoe Bay, 0.75), (Lilloet, 4.5), (Pemberton, 2.75), (Squamish, 1.5), (Whistler, 2.5)}

Try these:

Animal	Class
Ant	Insecta
Eagle	Aves
Snake	Reptilia
Turtle	Reptilia
Whale	Mammalia

1. DESCRIBE THE ABOVE RELATION IN WORDS.

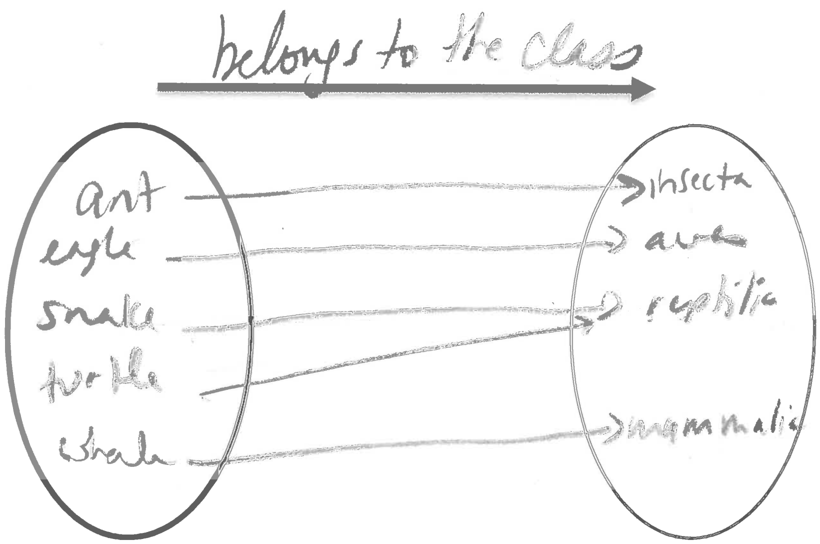
The relation shows the association "belongs to the class" between a set of animals and a set of classes.

Ant $\xrightarrow{\text{belongs to the class}}$ Insecta

2. REPRESENT AS A SET OF ORDERED PAIRS

{(ant, insecta); (eagle, Aves); (snake, reptilia); (turtle, reptilia); (whale, mammal)}

3. REPRESENT AS AN ARROW DIAGRAM.



When the elements of either one or both sets in a relation are in fact **numbers**, the relation can be represented as a bar graph as well (not always line graphs).

Words: The relation shows the association of "has a maximum speed" between a set of animals and a set of maximum speeds in km/h. For example, bison has a maximum speed of 35 km/h.

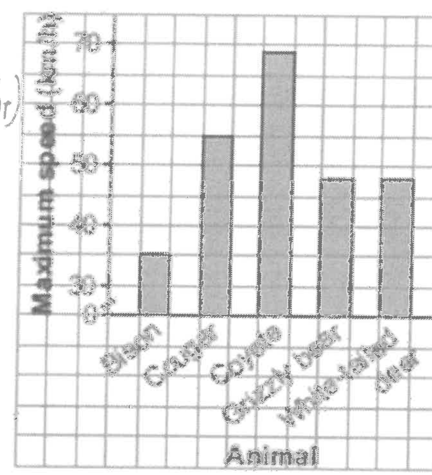
2.

Consider the relation represented by this graph. Represent the relation:

a) as a table

b) as an arrow diagram

Maximum Speeds of Different Animals



animal	max speed (km/h)
bison	35
cougar	55
coyote	69
grizzly bear	48
white-tailed deer	48

has a max speed (km/hr) of

bison → 35
cougar → 55
coyote → 69
grizzly bear → 48
white-tailed deer → 48

Both sets in a relation can be the same.

Sometimes a relation contains so many ordered pairs that it is impossible to list all of them or to represent them in a table or an arrow diagram.

3. In the diagram below:

a) Describe the relation in words.

The relation shows the association "has this number of letters" for the set "English words" and "natural numbers".

b) List 2 ordered pairs that belong to the relation.

(dog, 3) (bicycle, 7)

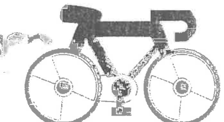
$$\boxed{\text{English words}} \xrightarrow{\text{has this number of letters}} \boxed{\text{Natural numbers}}$$

Introduction

Caitlin rides her bike to school every day. The table of values below shows her distance from home as time passes.

time (minutes) t	distance (metres) d
0	0
1	250
2	500
3	750
4	1000
5	1250

250



a) Write a sentence that describes this relation.

The relation shows the association "has a distance of" for the set "time (min)" and "distance from home (m)".

b) Represent this relation with ordered pairs.

{(0,0); (1,250); (2,500); (3,750); (4,1000); (5,1250)}

c) Represent this relation with an arrow diagram.

has a distance of (m)

0 → 0
1 → 250
2 → 500
3 → 750
4 → 1000
5 → 1250

d) Write an equation for this scenario.

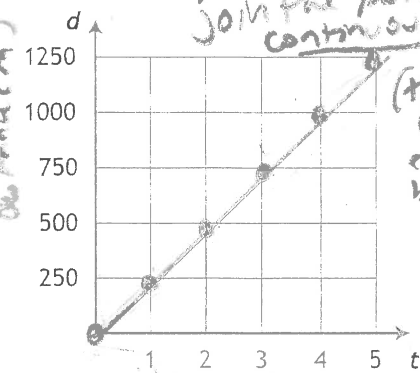
$d = 250t$

$d = 250(0) = 0$

$d = 250(1) = 250$

e) Graph the relation.

e)



distance (m)

time (min)

Join the points continuous data

(time + distance exist between given values)

Example 1

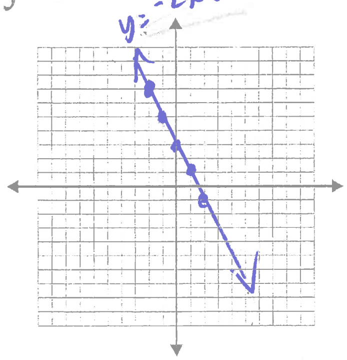
For each relation, complete the table of values and draw the graph.

a) $y = -2x + 3$

$y = -2(-2) + 3 = 7$

x	y
-2	7
-1	5
0	3
1	1
2	-1

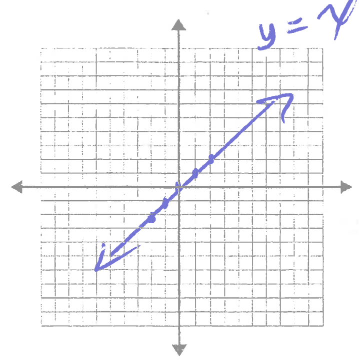
$y = -2x + 3$



b) $y = x$

x	y
-2	-2
-1	-1
0	0
1	1
2	2

$y = x$



Do page 262 #9 (a + b), 12, 13, 14

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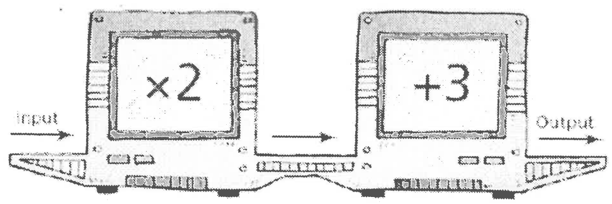


input

Input (x)	Output (y)
+1 (1	5) +2
+1 (2	7) +2
+1 (3	9) +2
+1 (4	11) +2
+1 (5	13

$y = 2x + 3$
= output

What is the rule you see for this Input/Output machine above?

Multiply input number (first column of table) by 2. Then add 3 to the result. This rule produces the output (number in second column of table).

Which numbers would complete this table for the machine?

5.2 Properties of Functions - RECOGNITION OF FUNCTIONS VS RELATION p. 265

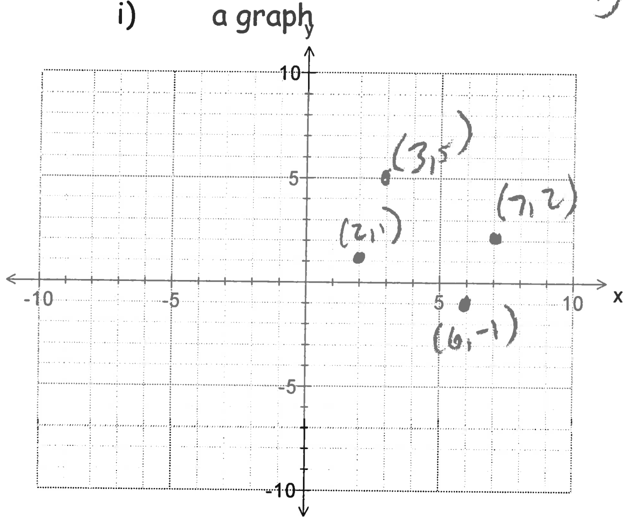
- A relation is any set of ordered pairs. It represents a relationship between two quantities or a correspondence between two variables.

- Relations may be represented in many ways. The most common being ordered pairs, a table of values, a graph or a mapping diagram.

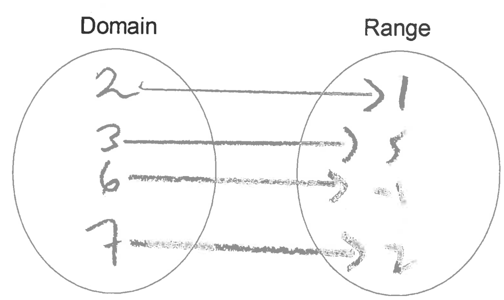
Example: The relation written as a list { (2, 1), (3, 5), (6, -1), (7, 2)} could be represented as

x, y

i) a graph



ii) a mapping diagram



iii) Table of Values

x	2	3	6	7	
y	1	5	-1	2	

The set of first elements (those typically corresponding to the x-values, or the independent variable) is the **DOMAIN**.

The set of second elements (those typically corresponding the y-values or the dependent variable) is called the **RANGE**.

A **FUNCTION** is a special type of relation where each element in the **domain** is used only once.

A function is a type of relation for which each x value in the domain corresponds with only one y value.

Ex: { (2, 1), (3, 5), (6, -1), (7, 2)} is a function because there is only one y for each x.

Ex: {(2, 3), (3, 1), (5, 4), (2, 6)} is not a function because when x = 2, there are 2 y-values.

Examples: **Are these functions?**

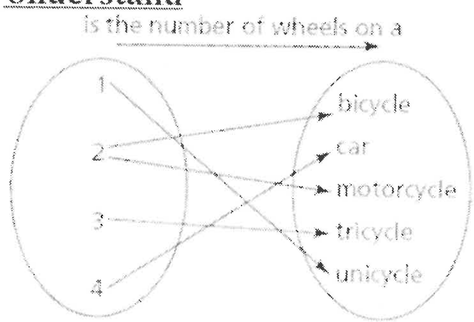
1) {(3, 8), (4, 9), (5, 10), (6, 11)} yes

2) {(-1, 7), (-1, 5), (-1, 3), (-1, 1)} no

3) {(5, 9)} yes

4) {(3, 3), (4, 4), (4, 5), (5, 5), (5, 6)} no.

Understand



This relation associates a number with a vehicle with that number of wheels.

This diagram DOES NOT represent a function because there is one element in the first set that associates with TWO ELEMENTS in the second set.

One specific input value has more than one output value.

Example 1: For each relation below,

- Identify its domain and range.
- Decide whether the relation is a function.

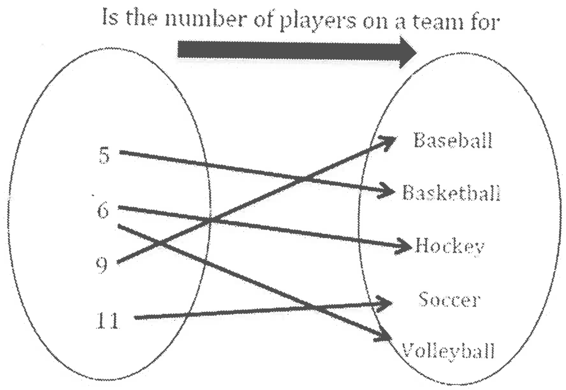
a) A relation that associates 5 foods to the food groups to which they belong: {(orange, fruit), (cheese, dairy), (broccoli, vegetables), (milk, dairy), (kiwi, fruit)}

Domain: {orange, cheese, broccoli, milk, kiwi}

Range: {fruit, dairy, vegetables}

Function? Yes each element of food goes to one food group. There isn't one food that goes to 2 food groups. Each element in first set associate with only one element in second set. Every ordered pair has a different first element. (It is okay to have food groups, second elements, repeat.)

b)



Domain: { 5, 6, 9, 11 }

Range: { baseball, basketball, hockey, soccer, volleyball }

Function? NO.
6 players has two teams
1st element
2nd element

Write the relation in words:
The relation associates the number of players on team with a sport.

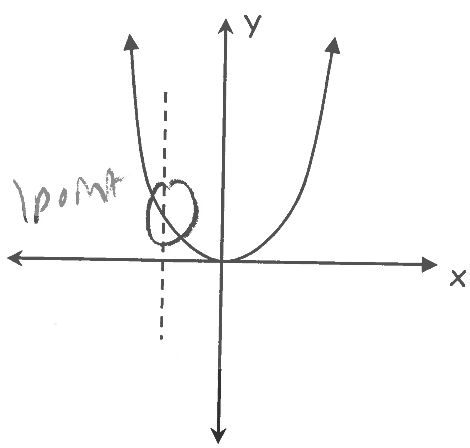
Write this relation as ordered pairs.
{ (5, basketball), (6, hockey), (6, volleyball), (9, baseball), (11, soccer) }

Straight line test to see whether or not a graph is a function

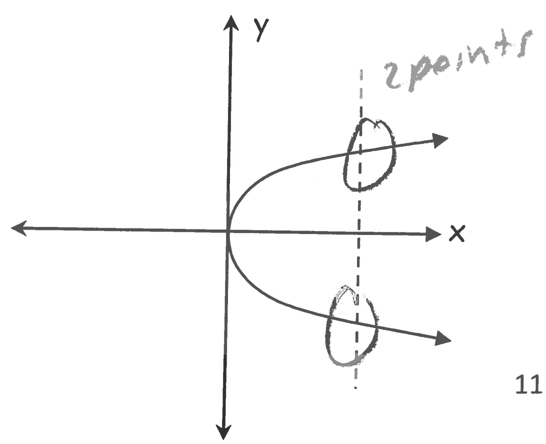
- To determine whether a **graph** is a function or not, we may apply the Straight line test. Since a function has only *one y-value for* every *x-value*, a straight line will cross the graph of a function in no more than One point.

- If the *vertical line* crosses the graph of a relation in More *than* One *point*, the relation is NOT a function.

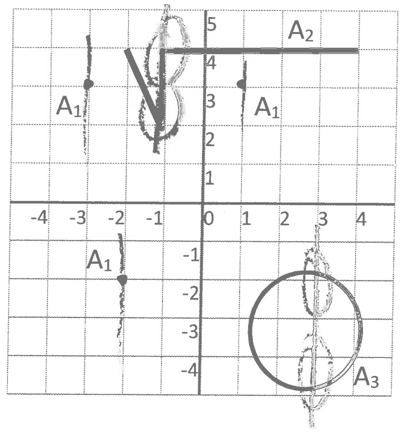
Function

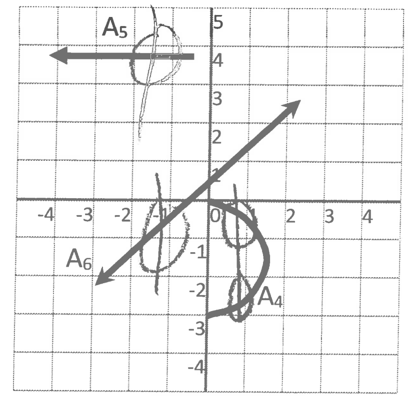


Not a Function



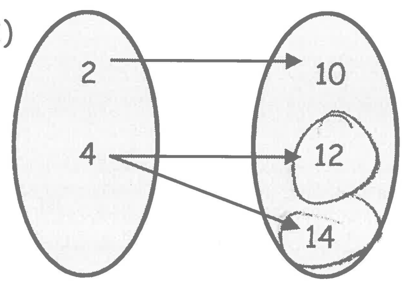
Are these functions?





1) A_1 ? yes A_2 ? NO A_3 ? NO A_4 ? NO A_5 ? yes A_6 ? yes

2)

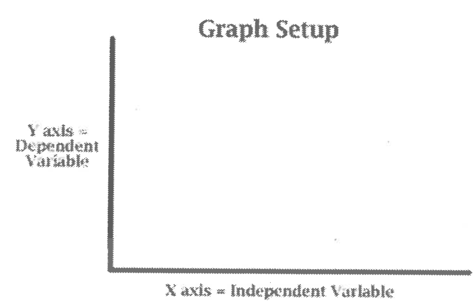


no.

3)

x	0	2	-2	4	-3
y	1	5	-3	9	-5

yes.



Dependent and Independent Variables

In any given model or equation, there are two types of variables:

- **Independent variables** - The values that can be changed in a given model or equation. They provide the "input" which is modified by the model to change the "output." It is not affected by the other variable. ***It is the "cause".*** It is usually placed on the horizontal, or x-axis.

For example, someone's **age** might be an **independent variable**. Other factors (such as what they eat, how much they go to school, how much television they watch) aren't going to change a person's age. In fact, when you are looking for some kind of relationship between variables you are trying to see if the independent variable causes some kind of change in the other variables, or dependent variables

- **Dependent variables** - The values that result from the independent variables. The dependent variable **depends** on the value that is input. It is affected by the change in the independent variable. Its value is determined by the choice of independent variable. ***It is the "effect".*** It is usually placed on the vertical, or y axis. It is the 'output'!
(see example on next page)

(dependent variable, continued)

For example, a test score could be a **dependent variable** because it could *change depending on several factors such as how much you studied, how much sleep you got the night before you took the test, or even how hungry you were when you took it.* Usually when you are looking for a relationship between two things you are trying to find out what makes the dependent variable change the way it does.

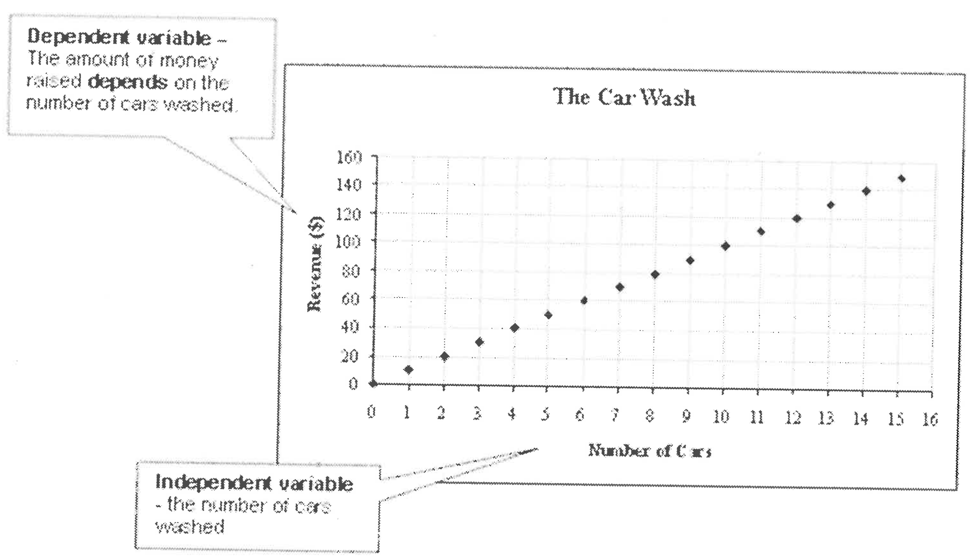
Many people have trouble remembering which is the independent variable and which is the dependent variable. An easy way to remember is to insert the names of the two variables you are using in this sentence in the way that makes the most sense. Then you can figure out which is the independent variable and which is the dependent variable:

(Independent variable) causes a change in (Dependent Variable) and it isn't possible that (Dependent Variable) could cause a change in (Independent Variable).

For example:

(Number of cars washed) causes a change in (revenue $ [*the amount earned*]) and it isn't possible that (revenue) could cause a change in (# of cars washed).

We see that "number of cars washed" must be the independent variable and "revenue" must be the dependent variable because the sentence doesn't make sense the other way around.



As the number of cars goes up, the revenue goes up.

We can think of a function as an input/output machine. **The input can be any number in the domain** (the *horizontal value on the x-axis*) and the **output** (the *vertical value on the y-axis)* **depends on the input.** So the domain is the independent variable and the output is the dependent variable.

In a relation, the input is the **independent variable**. The output is the **dependent variable**, because the value of the output depends on the value of the input.

Relation

$$y = -3x + 5$$

↑ ↑

Dependent Variable, y (Output) — Independent Variable, x (Input)

When a relation is shown as a graph, the independent variable is shown on the horizontal axis and the dependent variable is shown on the vertical axis.

The **domain** of a relation is the set of all the possible values for the independent variable. The **range** of a relation is the set of all the possible values for the dependent variable.

example, if C = 15 + 2n, this notation shows that C is dependent variable as it depends on n.

Try these:

1. The table shows masses of different numbers of Canadian quarters.

Number of Quarters, n	Mass, m (g)
1	4.4
2	8.8
3	13.2
4	17.6
5	22.0

The mass of quarters, m, depends on the number of quarters, n.

We say that the mass is the dependent variable and the number of quarters is the independent variable.

Domain: {1, 2, 3, 4, 5}

Range: {4.4, 8.8, 13.2, 17.6, 22.0}

Is the relation also a function? Why? Yes / no because every 'number of quarters' has only one 'mass'

2. This table shows sample costs for a pay-as-you-go cell phone plan.

Number of Minutes, n	Cost, C ($)
10	2
20	4
30	6
40	8
50	10

a) Is this relation also a function? yes

b) Identify the independent and dependent variables. number of minutes cost

c) Write the domain and range. → {2, 4, 6, 8, 10}

{10, 20, 30, 40, 50}

Function Notation

We can write an equation that represents a function, using FUNCTION NOTATION.
Any function that can be written as an equation in two variables can be written in function notation.

→**Example**:

The revenue is a function of the number of cars washed. The equation **R = 10 n** represents the revenue.

When the input is n, number of cars, the revenue, R, in dollars is R = 10n. Since R is a function of n, we can write an equation that represents this function using ***function notation.***

To show R = 10n is a function, we describe or write it in function notation: **R (n) = 10 n**

We say: *R depends on n* *"R of n"*

R of n is equal to 10 times n or 10n

This notation shows that **R** is the **dependent variable** and that **R depends on n.**

R (6) represents the value of the function when n = 3. It represents the revenue when there are 3 cars washed.
R (n) = 10n
R (6) = 10 (6)
R (6) = 60
So the revenue when 3 cars is washed is $60.

a) Determine or find R (5).

R(n) = 10n
R(5) = 10(5)
R(5) = 50

This number represents that when 5 cars are washed, the revenue is $ 50.

b) Determine or find the value of n when R (n) = 80. What does this number represent?

R (80) = 10(80) = 800

This $800 represents the revenue when 80 cars washed.

Try these: Carmen works for a research company in a shopping mall.
The equation $P = 5n + 30$ represents her daily pay, P dollars, when she conducts n surveys.

a) Describe the function. Write the equation using function notation.

The pay Carmen receives is a function of the number of surveys she conducts.
$\boxed{P(n) = 5n + 30}$

b) Find the value of P(8). What does this number represent?

$P(8) = 5(8) + 30$
$= 40 + 30$
$= 70$

$70 is the pay she receives after conducting 8 surveys

c) Find the value of n when P(n) = 90. What does this number represent?

$P(n) = 5n + 30$
$90 = 5n + 30$
$60 = 5n$
$12 = n$

12 is the number of surveys she conducts to earn $90.

Example 2: Write in function notation.

a) $P = 2s + 15$

$P(s) = 2s + 15$

b) $y = -3x + 5$

$y(x) = -3x + 5$

Write as an equation in 2 variables.

a) $d(t) = 4t - 7$

$d = 4t - 7$

b) $g(x) = -2x - 3$

$g = -2x - 3$

Example 3: Given $f(x) = x^2 - 6$

a) Find f(0)

$f(0) = 0^2 - 6$
$f(0) = -6$

b) Find f(10)

$f(10) = 10^2 - 6$
$f(10) = 94$

c) Find x if f(x) = 30

$30 = x^2 - 6$
$36 = x^2$
$6 = x$

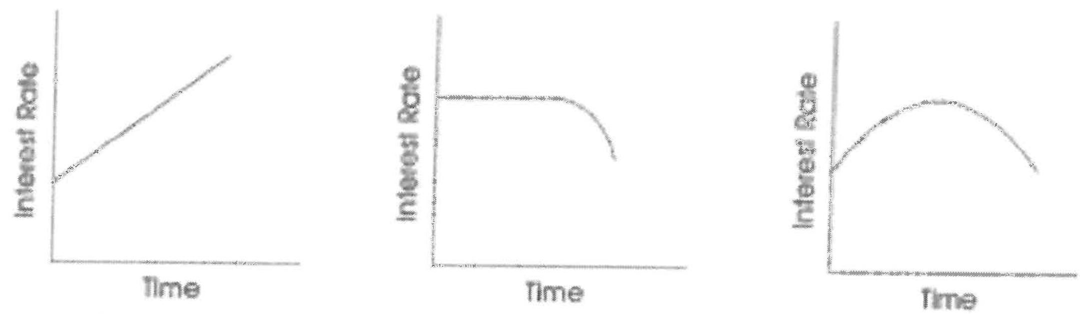
Practice 5.2 p. 270-272 #1,3,4,5,9,14,18.

5.3 Interpreting and Sketching Graphs p. 276

5.3 INTERPRETING AND SKETCHING GRAPHS

The shape of a graph can tell us a great deal even if there are no numbers on the axes. For example, the set of graphs below show how interest rates have changed over one year in three different countries.

Change in Interest Rate



The first graph shows that interest rates in that country rose steadily throughout the year.

The second graph shows that interest rates were high at the beginning of the year, remained constant for most of the year, and dropped rapidly for the last part of the year.

The third graph shows that interest rates increased rapidly at first, then more slowly to reach a maximum about halfway through the year, and decreased for the rest of the year.

Hints for interpreting graphs:

- When the value of the independent variable is zero, what is the value of the dependent variable? Does it make sense?
- As the value of the independent variable increases, does the value of the dependent variable increase or decrease? What does this mean for these particular variables? Does it make sense?
- Does the value of the dependent variable change at a steady rate? If not, how does it change? Is the change faster at first and slower later on . . . or is it slow at first and faster later on?

"A picture is worth a thousand words." Graphs are a picture of data. In this section you will investigate how to create and interpret the "story" graphs are telling.

- Speed represents the change of distance over time
- Speed = d/t
- Velocity is speed with a direction
- A negative velocity indicates a movement in the opposite direction. Slope = Speed (m= "rate" of speed)

Walking Slowly (Least steep)

Walking Normally

Walking Quickly (Steepest)

Stops m = 0

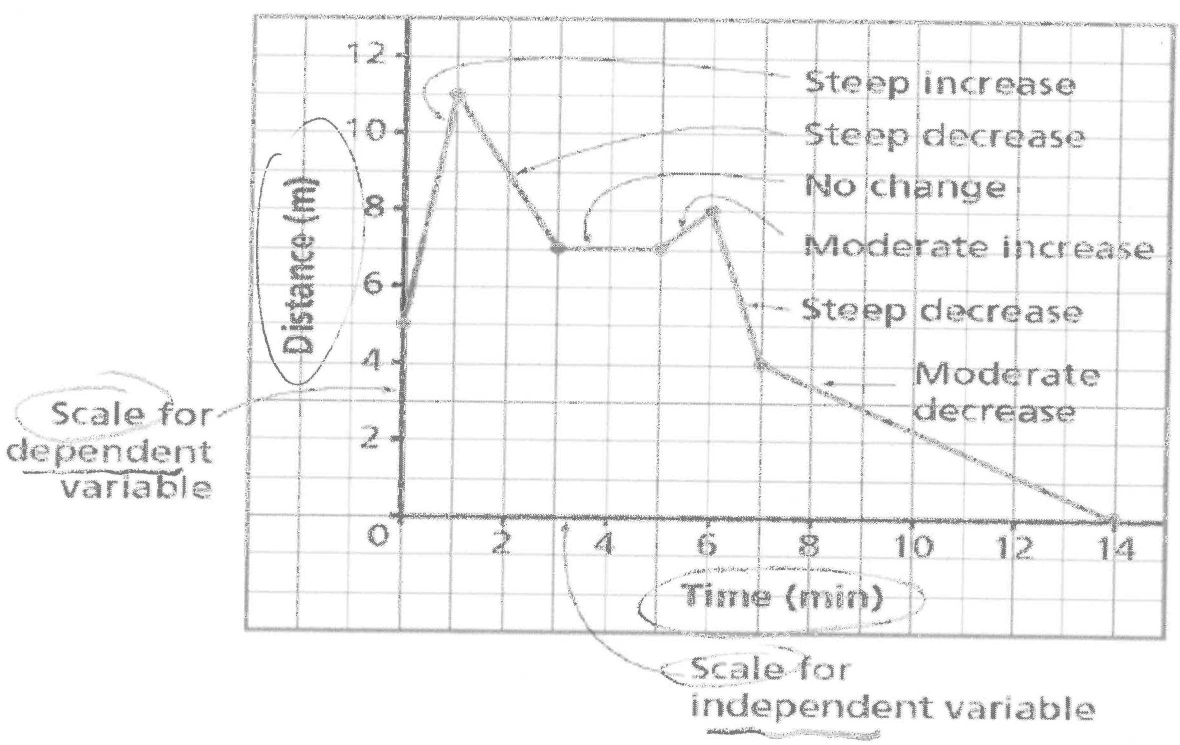
Positive Slopes have lines that are in an upward direction

Negative Slopes have lines that are in a downward direction

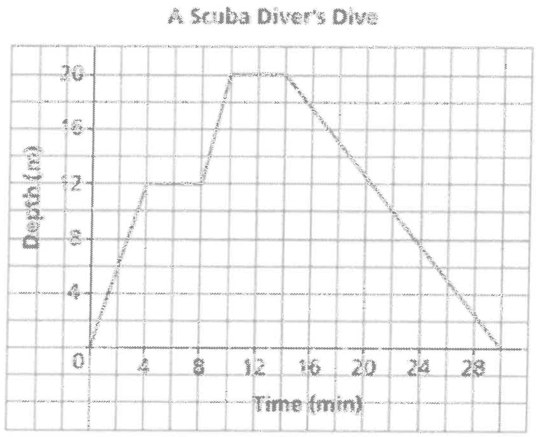
Graphs can provide much information

- ☐ Look at title, and axis labels to gather as much info as possible
- ☐ Think of realistic reasons for what is happening in the graph

Properties of a Graph



Example 1: Consider the following graph:



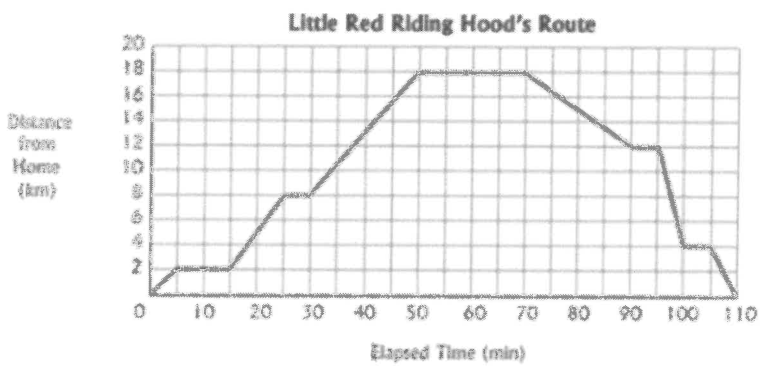
a) How many minutes did the dive last? 30

b) At what times did the diver stop her descent?
4 min, 10 min   14-30 ascent

c) What was the greatest depth the diver reached?
20m For how many minutes was the diver at that depth?
4 min.

Example 2: ←

When interpreting a broken-line graph, keep in mind what information is being displayed on the axes. For example, the graph below shows the journey taken by Little Red Riding Hood on her motor scooter from her home to her grandma's house. More specifically, the graph shows the distance (in kilometres) of Little Red Riding Hood from her home over time (in minutes). It also shows the speed at which she travelled along her route. ←(velocity)



a. Write a brief description of the situation depicted in the graph.
Little Red Riding Hood walks to grandmother's house, stays a while, then comes home. But her velocity increases and decreases both ways when running/walking and sometimes stops (talking to wolf? picking flowers?)

b. How long did her journey take in total? ⇨ 110 min

c. Where did she end up at the end of her travels? ⇨ home

d. At what time did she reach her grandma's house? ⇨ 50 mins

e. How long did she stay at her grandma's house? ⇨ 20 min

f. How many times did she stop on her journey? ⇨ 5 (incl. at grandma's)

$18-8=10$

$V = \frac{D}{T}$ ← 20

g. What was Riding Hood's ~~speed~~ velocity between 30 and 50 min? ⇨ 0.5 km/h

$V = \frac{10}{20} = 0.5$ km/h.

h. When was she travelling at the fastest speed? ⇨ 95 - 100 min

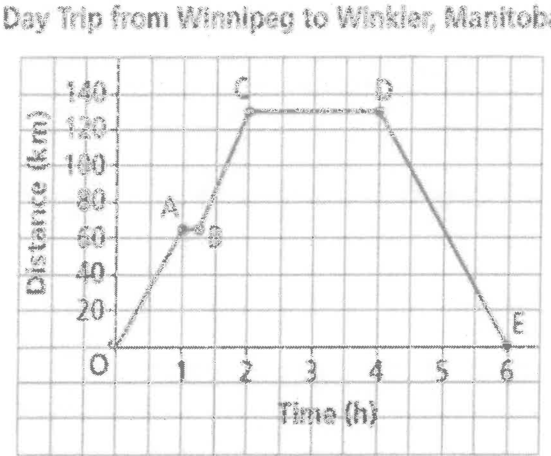
i. During the first half of her journey, the slopes are mostly positive (ie. go up), whereas the slopes for the second half are mostly negative (ie go down). What does this mean? distance from her house is decreasing

time ↑ distance from home on way home ↓

$\frac{rise}{run} = \frac{1}{1} = 1$ time ↑ distance from home on way there ↑

$\frac{rise}{run} = \frac{-1}{1} = -1$

Example 3: This graph represents a day trip from Winnipeg to Winkler. The distance is approximately 130 km.

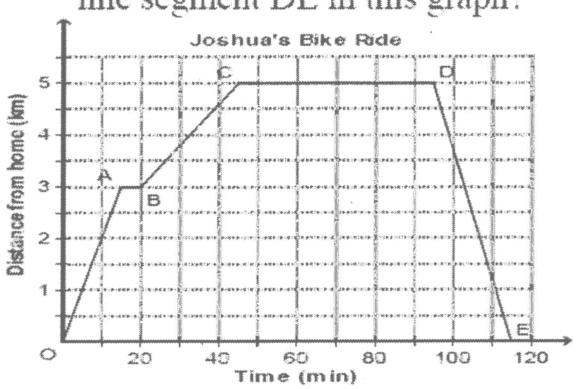


The distance between Winnipeg and Winkler is 130 km.

a) Describe the journey for each segment of the graph.

segment	graph	journey
$\overline{OA}$	*The graph goes up to the right. As time increases, the distance from Winnipeg increases.*	*Travelled 65 km in first hour of trip.*
$\overline{AB}$	The graph is horizontal.	stopped ½ hr. (lunch break?)
$\overline{BC}$	Graph goes up to right. As time increases, distance from Winnipeg increases	back on road 1.5 hr.
$\overline{CD}$	The graph is horizontal.	stopped 2 hrs. (visit)
$\overline{DE}$	The graph goes down to right. As time increases, distance from Winnipeg decreases.	returned home 2h no stops.

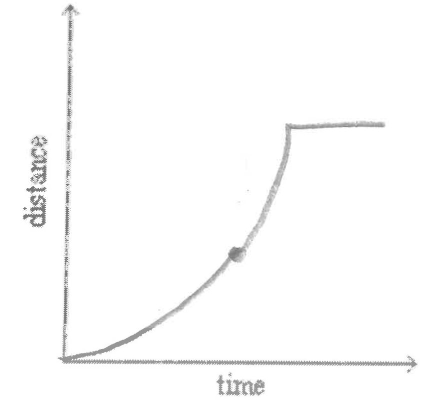
Example 4: Joshua went on a bike ride. Which statement best describes what is happening for line segment DE in this graph?



a) Joshua spends time at the park. b) Joshua leaves home. c) Joshua cycles to the park. d) Joshua returns home.

5. Draw the graph that represents the following:

- A log floats in a slow, steadily moving stream.
- It goes through 2 sets of rapids; the second is faster than the first.
- It then goes over a waterfall into a lake.

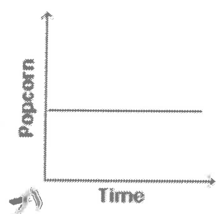


6. Match each situation to one of the graphs.
Use a ruler to draw a straight line from the situation to the correct graph.

(Or write letter of situation beside graph.)

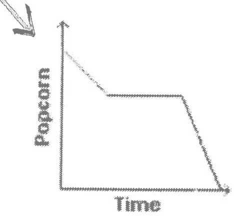
(a) Melissa eats her popcorn for a short time.
She stops eating to speak to her friend Sam.
Then she finishes eating her popcorn very quickly.

C



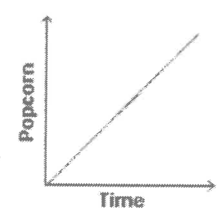
(b) Melissa makes popcorn at a constant rate before the movie

A



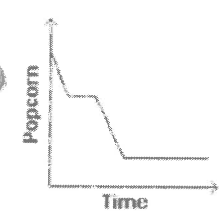
(c) Melissa does not eat any of the popcorn she has made.

B



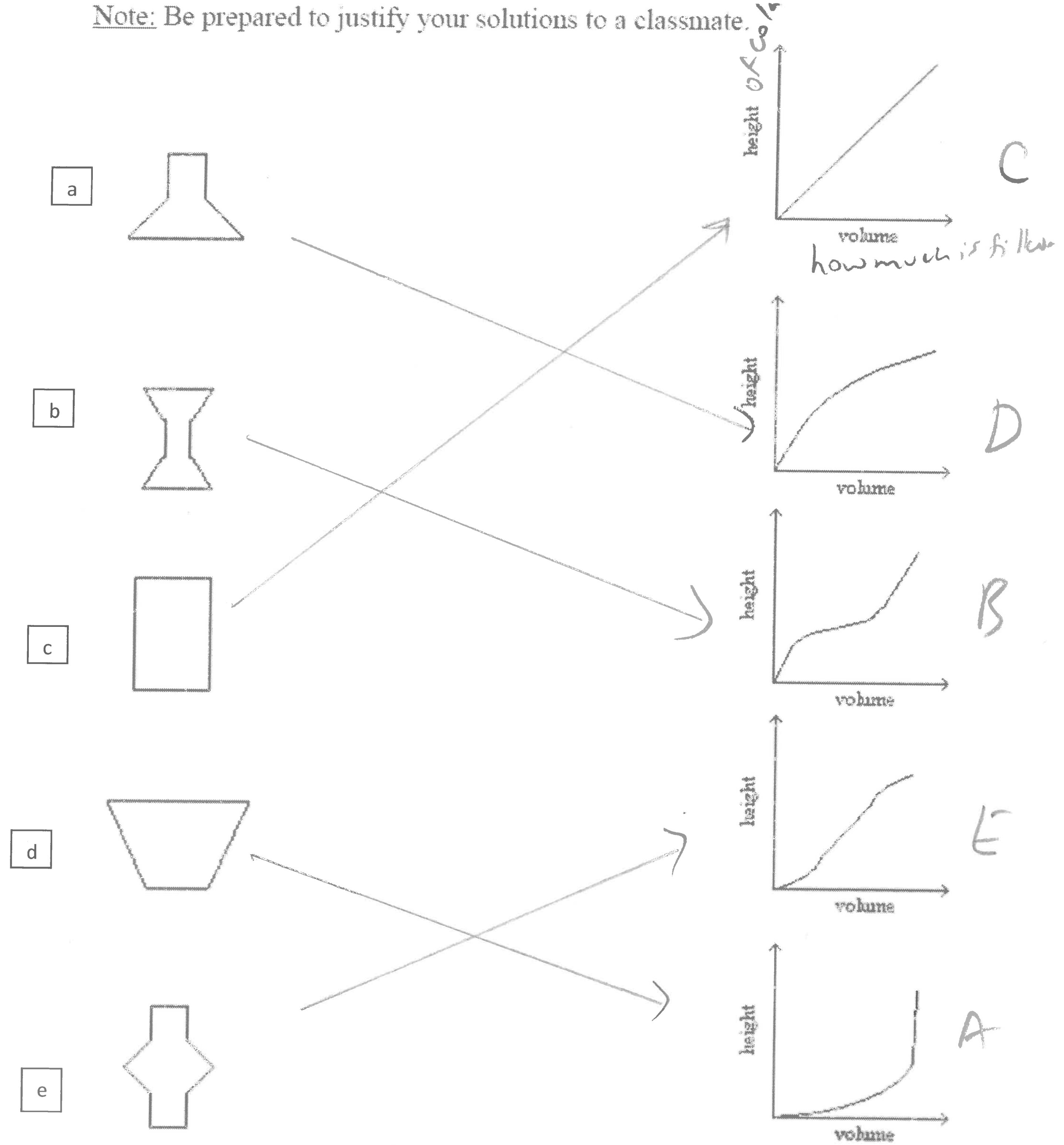
(d) Melissa eats her popcorn quickly for a short time.
She stops eating during the intermission of the movie.
She begins eating again when the movie starts, but she does not finish the popcorn because she is feeling full.

D



7. Imagine that you are pouring cola into each of these glasses at a constant rate. Match eac glass to the graph that best represents the filling process. *Use a ruler to draw a straight line the situation to the correct graph.* (Or write letter of situation beside graph.)

Note: Be prepared to justify your solutions to a classmate.

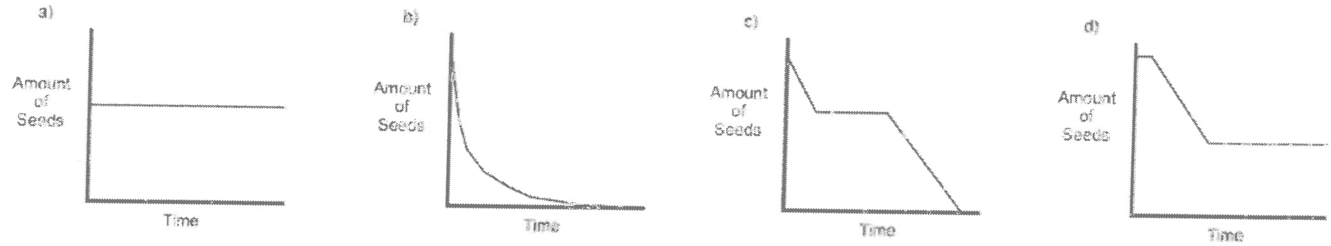


Try these

1. Sunflower Seed Graphs

Ian and his friends were sitting on a deck and eating sunflower seeds. Each person had a bowl with the sa amount of seeds. The graphs below all show the amount of sunflower seeds remaining in the person's bov over a period of time.

Write sentences that describe what may have happened for each person.



didn't eat them

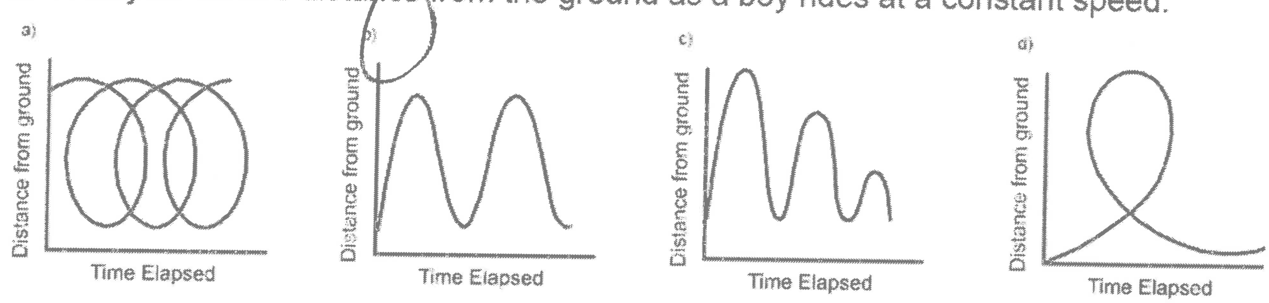
ate a lot quickly then more slowly until gone

ate. stopped, ate again until gone.

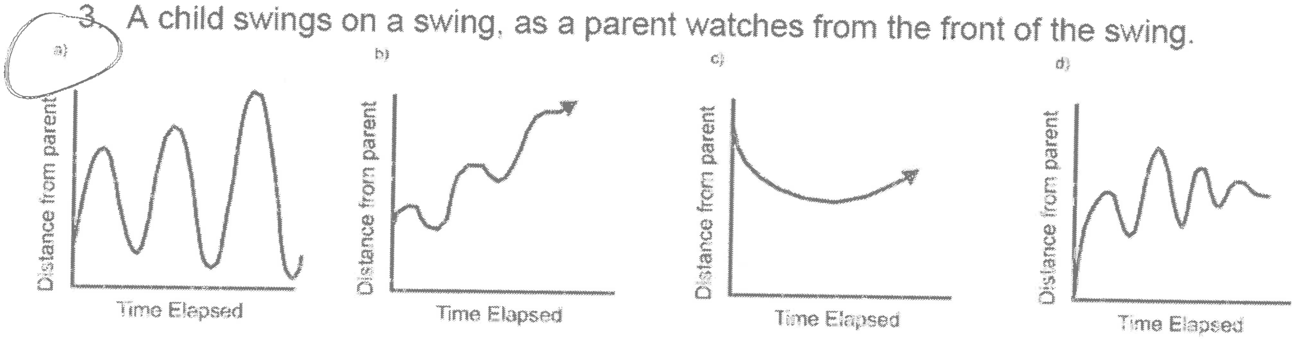
waited. ate. stopped, (not all gone.)

Indicate which graph matches the statement. Give reasons for your answer.

2. A bicycle valve's distance from the ground as a boy rides at a constant speed.



3. A child swings on a swing, as a parent watches from the front of the swing.



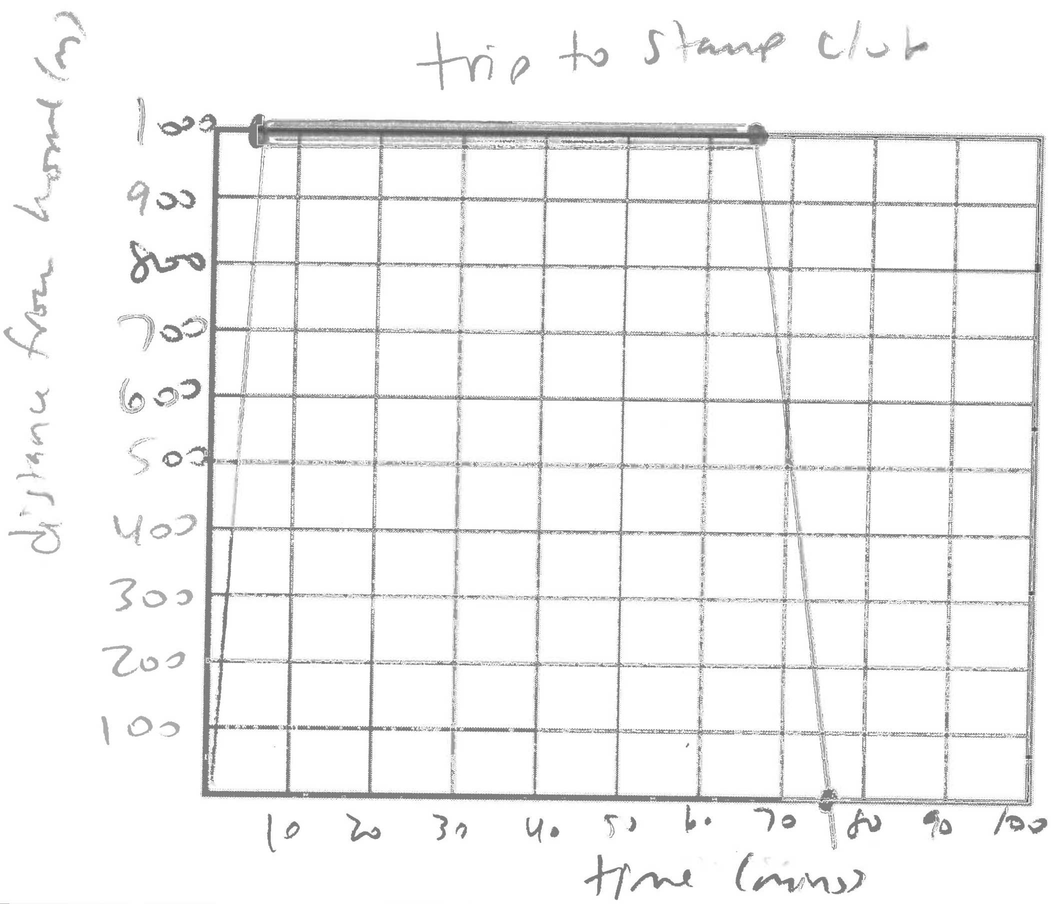
3. You are at home getting ready to go out to your stamp collecting club.

You leave your house and jog the 1000m to the club. You arrive 5 minutes later.

You exchange stamps and chat for 1 hour, then leave for home. It takes you 10 minutes.

Plot a distance time-graph to represent your journey to and from the club.. a graph of speed as a function of time. Label each section of your graph, and explain what it represents.

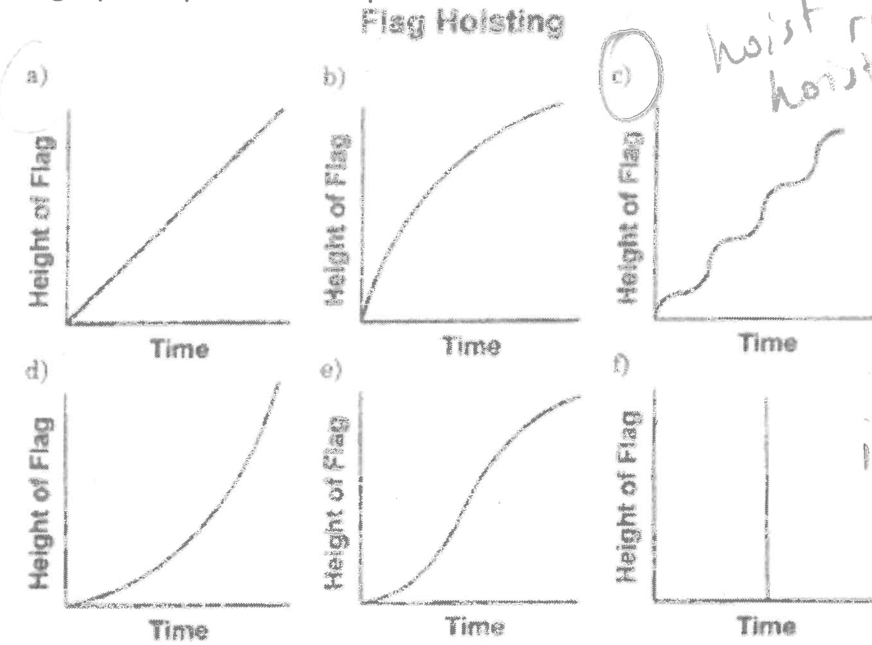
(Don't forget: Choose a suitable scale for each axis. Decide how many points to plot. Draw the graph with suitable accuracy. Provide a title and label each axis. Give your graph a title, label each axis, and choose an appropriate scale for each variable.)



5.3 practice p. 281 – 283 (Some questions can be answered on reverse. You will need graph paper for one of the questions.) #1,4,5,8, 10, 13, 15

Extra practice 5.3

1: Every morning at camp, one of the scouts hoists a flag to the top of a flagpole. The graphs below show the height of the flag as a function of time. Which do you think models the situation most realistically? If you think none of the graphs is realistic, draw your own version and explain it. Do any of the graphs represent an impossible situation?



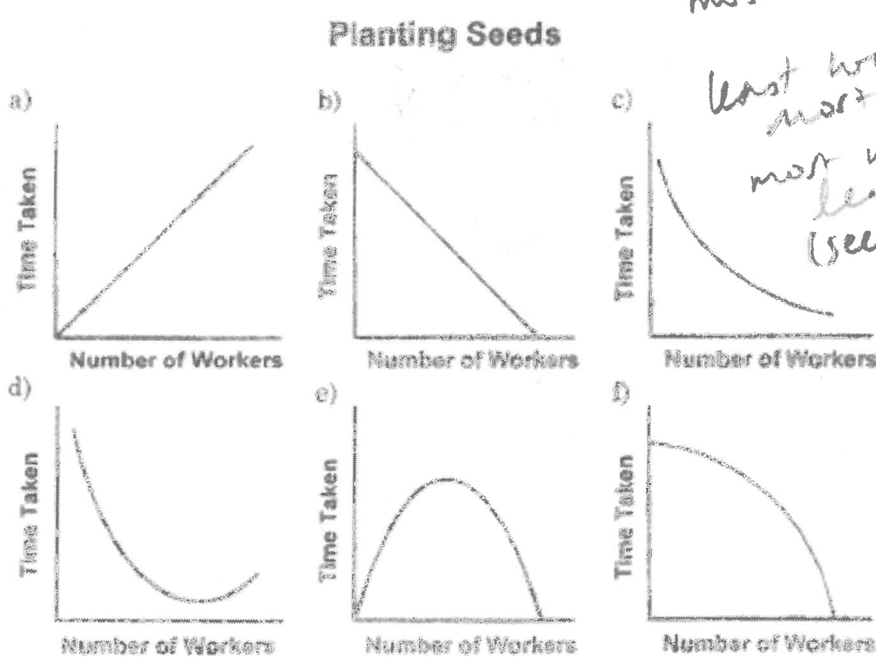
hoist regrip hoist regrip

impossible ex time is 3 seconds and ... flag jumps to top. and it didn't rise ... etc.

must start with 1 person.

2: A group of city workers have to plant a large number of seedlings, Which of the following graphs models most realistically the relationship between the number of workers involved and the time it takes to complete the job? Explain your answer.

p.54



least workers most time most workers least time. (seedlings not planted by 0 workers)

double time 1 people to plant 2 people

graph cannot meet either axis

Can never be so many people that it takes 0 minute.